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FILLING AND CIRCULATING APPARATUS FOR SUBSURFACE EXPLORATION

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FILLING AND CIRCULATING APPARATUS FOR SUBSURFACE EXPLORATION

FIELD OF THE INVENTION

[0001] This invention relates to filling a portion of casing while it is being run in a wellbore and circulating it to aid in its proper positioning as it is being advanced into the wellbore.

BACKGROUND OF THE INVENTION

[0002] Casing for a wellbore that has just been drilled is assembled at the surface as joints are added and the string is lowered into the wellbore. As the joints are added at the surface on the rig floor, it is often desirable to fill the casing with fluid or drilling mud. Filling the casing before it is run into the wellbore prevents pressure imbalances on the casing as it is being advanced into the wellbore. Additionally, once the casing is filled, it may be desirable to circulate through the casing as it is being run into the wellbore. Thus, it is often necessary to use an apparatus for filling and circulating fluids within the casing. When such an apparatus is raised from the casing, fluids may leak onto the well deck, which wastes valuable fluids, may be hazardous to personnel, and could cause environmental issues. Furthermore, such an apparatus may build up excessive back pressure causing potentially dangerous situations. What is needed, therefore, is an apparatus and method which safely allows for the adequate filling and circulating of the casing.

SUMMARY

[0003] The present invention relates to a filling and circulating tool and a method of use thereof. The filling and circulating tool comprises a housing having a first fluid passage and a longitudinal axis, a movable seal coupled to an exterior of the housing, the seal adapted to substantially block a flow of fluid through the first fluid passage when the seal is in a closed position and to allow the flow of fluid when the seal is in an open position, and an actuating device coupled to the movable seal such that in response to insertion into the casing, the actuating device causes the movable seal to move from the closed position to the open position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Fig. 1 is a longitudinal cross section of one embodiment of the present invention.

[0005] Fig. 2 is an elevation of the embodiment of Fig. 1 illustrating the embodiment in a closed position.

[0006] Fig. 3a is a detailed cross section of one embodiment of a valve apparatus which could be employed in the embodiment of the present invention.

[0007] Fig. 3b is a detailed cross section of an alternative embodiment of a valve apparatus which could be employed in the embodiment of the present invention.

[0008] Fig. 4 is an elevation of the embodiment of Fig. 1 illustrating the embodiment in an open position.

DESCRIPTION

[0009] Referring now to Fig. 1, there is shown an embodiment of a filling and circulating tool 10. As will be explained below with reference to the operation of the filling and circulating tool 10, Fig. 1 illustrates a first or "closed" configuration. The filling and circulating tool 10 has an outer housing 12 which is generally cylindrical in shape and encloses the various modules and components of one embodiment of the present invention. At the upper end of the outer housing 12, there is an upper connecting sub 14 which is adapted to be connected to the bottom of a tool string (not shown) in a conventional manner.

[0010] A top opening 16 is concentrically located in the upper connecting sub 14. The top opening 16 defines an end of a first fluid passageway or central throughbore 18 which generally runs through the filling and circulating tool 10 along a vertical or longitudinal axis 20. In one embodiment, the upper connecting sub 14 has a threaded inside surface 22 adapted to connect to the tool string (not shown). The lower end of the upper connecting sub 14 may be connected to a tubular shaped mandrel 24 in a conventional manner, for instance, by means of a threaded connection 25. The interior of the mandrel 24 defines a portion of the central throughbore 18. A sealing means, such as a plurality of O-rings (not shown) may provide a sealing engagement between the upper connecting sub 14 and the mandrel 24.

[0011] In the illustrative embodiment of Fig 1, the lower end of the mandrel 24 connects to a valve body 26 in a conventional manner, such as a threaded connection 28. A sealing means, such as a plurality of O-rings (not shown) may provide a sealing engagement between the mandrel 24 and the valve body 26. As will be explained in detail below, the valve body 26 contains a plurality of fluid ports 30 which are in communication with the central throughbore 18. In the configuration illustrated in Fig. 1, a valve sleeve 32 is slidably coupled to the valve body such that the valve sleeve 32 may move longitudinally with respect to the valve body 26 from a "first" or closed position to a "second" or open position. As will be explained in detail below, in the closed position, the valve sleeve 32 covers the fluid ports 30 to prevent fluid from exiting. On the other hand, in the open position, the valve sleeve 32 does not cover the fluid ports 30, allowing fluids to escape. The valve sleeve may have a means of protection, such as a urethane standoff ring 31, to protect against casing and thread damage. Additionally, the standoff ring 31 may act as a guide to assist in centralizing the tool 10 within the casing.

[0012] An actuating device 38 may be coupled to the valve sleeve 32. The actuating device 38 causes the valve sleeve 32 to move from the closed position to the open position. A lower end of the valve body 26 may be adapted to be coupled to a nose guide 34 which also contains a plurality of fluid passages 36. The nose guide 34 protects the filling and circulating tool 10 and aids in the insertion of the tool into the casing. The nose guide 34 can also protect the casing threads.

[0013] Turning now to Fig. 2, there is an exterior view of the filling and circulating tool

10. In the illustrated embodiment, the actuating device 38 is coupled to the exterior of the mandrel 24. The actuating device 38 may comprise an anchor collar 50, a collar or scissor sleeve 52, and a plurality of scissor arms 54a and 54b. The anchor collar 50 may be fixedly coupled to the mandrel 24. In alternative embodiments, the anchor collar 50 may function as a connecting sub which connects an upper mandrel 56 to a lower mandrel 58. The plurality of scissor arms 54a and 54b connects the anchor collar 50 to the scissor sleeve 52 and allows the scissor sleeve 52 to slidingly move longitudinally along the mandrel 24 with respect to the anchor collar 50. Lower segments 55a and 55b of the the scissor arms 54a and 54b may have a means of protection, such as urethane thread protectors 57a and 57b to shield the segments 55a and 55b when entering a casing.

[0014] The scissor sleeve 52 may be coupled to a plurality of connecting rods 60a and 60b (60a is visible in Fig. 2). In one embodiment, the ends of the connecting rods may be threaded. In such an embodiment, a lower end 59a of the connecting rod 60b may be threadably coupled to the valve sleeve 32. An upper end 59b of the connecting rod 60b may be positioned within a longitudinal bore (not shown) defined within the scissor sleeve 52. A plurality of locking nuts (not shown) positioned above and below the bore may be used to secure the upper end 59b of the connecting rod 60b to the scissor sleeve 52. Thus, as illustrated, the connecting rods 60a and 60b couple the scissor sleeve 52 to the valve sleeve 32 so that when the scissor sleeve 52 moves longitudinally, the valve sleeve 32 will follow with the same relative movement. In some embodiments, a center portion 59c of the connecting rods 60a and 60b may be positioned within and slidingly engage a longitudinal bore (not shown) defined within the anchor collar 50.

[0015] Fig. 3a is a detailed view of one embodiment of the valve body 26. As previously discussed, the upper end of the valve body 26 may be adapted to connect to the lower end of the mandrel 24 in a conventional manner, such as with the threaded connection 28. A top opening 64 is concentrically located in the valve body 26. The top opening 64 defines a concentric bore 66 which is a portion of the central throughbore 18. In the illustrative embodiment, the fluid ports 30a-30d run through the side walls of the valve body 26 (fluid ports 30a, 30b, and 30c are visible in Fig. 3a). A sealing mechanism, such as a plurality of O-rings 68a and 68b or U-cup seals (not shown) such as those commercially available from MARCO Rubber Plastic Products, Inc. of North Andover, Massachusetts, provide a seal

when the valve sleeve 32 (not shown in Fig. 3a) covers the ports 30.

[0016] At approximately the middle of the valve body 26, the concentric bore 66 narrows down to a neck 70 and then expands again to create a fluid passage 72. The fluid passage 72 may contain a valve mechanism, such as a nylon ball 74 positioned within the fluid passage 72. A biasing mechanism, such as a helical spring 75, may bias the ball 74 against the neck 70. In the illustrative embodiment, the force exerted by the helical spring 75 against the ball 74 may be adjusted by means of a threaded mechanism 77 positioned within the fluid passage 72.

[0017] The bottom portion 76 of the valve body 26 may be coupled to the nose guide 34 by means of a threaded connection 78. The nose guide 34 may be urethane, plastic, brass or another suitable material to protect the valve body 26 and casing threads during use. As will be explained below, the nose guide 34 may have a plurality of fluid passages 36a and 36b which may allow fluid to escape during times of high back pressure.

[0018] Fig. 3b is a detailed view of an alternative embodiment of a valve body 80. As illustrated, the valve body 80 is similar to the valve body 26 discussed in reference to Fig. 3a. The upper end of the valve body 80 may be adapted to connect to the lower end of the mandrel 24 in a conventional manner, such as with the threaded connection 28. A top opening 82 is concentrically located within the valve body 80. The top opening 82 defines a concentric bore 84 which may be a portion of the central throughbore 18. In the illustrative embodiment, the fluid ports 86a-86d run through the side walls of the valve body 80 (fluid ports 86a, 86b, and 86c are visible in Fig. 3b). A sealing mechanism, such as a plurality of U Cup seals 88a and 88b, provide a seal when the valve sleeve 32 covers the ports 86a-86d (as illustrated in Fig. 3b).

[0019] At approximately the middle of the valve body 80, the concentric bore 84 widens to form an a downward facing radial flange 90 coupled to a plunger seat 92. The widened portion of the concentric bore 84 forms a fluid passage 94. The fluid passage 94 may contain a valve mechanism, such as a plunger 96 positioned within the fluid passage 94. A biasing mechanism, such as a helical spring 98, may bias the plunger 96 against the plunger seat 92. In the illustrative embodiment, the force exerted by the helical spring 98 against the plunger seat 92 may be adjusted by means of a threaded mechanism, such as a compression nut 100, positioned within the fluid passage 94. In some embodiments, a

spacer sleeve 102 may be coupled to the compression nut 100 to longitudinally position the compression nut 100 within the fluid passage 94.

[0020] A bottom portion 104 of the valve body 80 may be coupled to a guide nose 106. The guide nose 106 may be urethane, plastic, brass or another suitable material to protect the valve body 80 during use. The guide nose 106 may have a plurality of fluid passages 108a and 108b which may allow fluid to escape during times of high back pressure.

OPERATION:

[0021] Referring now to Figs. 1, 2, and 4, the operation of the filling and circulating tool 10 will now be discussed. The upper connecting sub 14 of the filling and circulating tool 10 may be connected to a work string (not shown). Before insertion into the casing, filling and circulating tool 10 is in the closed position illustrated in Figs. 1 and 2. The work string is then lowered into a well bore containing a casing 81 (shown in Figs. 2 and 4). When the scissor arms 54a and 54b engage the top opening 83 of the casing 81, the scissor arms 54a and 54b laterally collapse inward towards the mandrel 24. The lateral collapsing of the scissor arms 54a and 54b causes the scissor arms 54a and 54b to push longitudinally against the scissor sleeve 52, which, in turn, causes the scissor sleeve 52 to move in a first direction 85 along the mandrel 24 towards the upper connecting sub 14.

[0022] As the scissor sleeve 52 moves in the first direction 85, it pulls the valve sleeve 32 in the first direction 85 via the connecting rods 60a and 60b. Thus, the valve sleeve 32 is pulled from a closed position to an open position (as illustrated in Fig. 4). In moving from the closed to open position, the valve sleeve 32 moves longitudinally in the first direction 85 along the mandrel 24 towards the top end of the upper connecting sub 14.

[0023] As the valve sleeve 32 moves from the closed position to the open position, the fluid ports 30 become exposed as illustrated in Fig. 4. Drilling fluids may now be circulated through the filling and circulating tool 10 as it is lowered into the casing. The fluids enter through the top opening 16 (Fig. 1) of the upper connecting sub 14. The fluids may flow through the central throughbore 18, and exit through the fluid ports 30a through 30d.

[0024] At some point, it may be desirable to remove the work string from the wellbore. Upon removal of the tool string, the filling and circulating tool 10 is lifted by the top connecting sub 14. When the scissor arms 54a and 54b move past the top opening 83 of

the casing 81, the weight of the scissor sleeve 52 and the valve sleeve 32 push down on the scissor arms 54a and 54b, causing them to expand laterally, as illustrated in Fig. 2. This lateral expansion of the scissor arms 54a and 54b allows the scissor sleeve 52 to move longitudinally in a second direction 87 along the mandrel 24 towards the nose guide 34.

[0025] As the scissor sleeve 52 moves in the second direction 87, it also allows the valve sleeve 32 to move in the second direction 87. Thus, the valve sleeve 32 moves back from the open position illustrated in Fig. 4 to the closed position as illustrated in Fig. 2. The plurality of O-rings 68 (Fig. 3a maintains a fluid-tight seal so that the fluids do not leak from the filling and circulating tool 10 as the tool is lifted from the casing opening 83.

[0026] With conventional filling and circulating tools, if a fluid pump (not shown) is left on for too long during the removal process, back pressure will develop within the tool string and the filling and circulating tool 10. The back pressure is undesirable and may result in an unsafe condition. Turning back to Figs. 3a and 3b if high back pressure occurs while using the filling and circulating tool 10, the pressure in the throughbore 18 will overcome the biasing force exerted on the ball 74 by the spring 75 or the plunger 96 by the helical spring 98, causing the ball 74 or plunger 96 to move longitudinally down the fluid passage 72 or 94, respectively. Once the ball is away from the neck 70, fluid may flow around the ball 74 down through the fluid passage 72. The fluid may exit through the fluid passages 36a and 36b or 108a and 108b, respectively, thereby relieving any excessive back pressure building in the central throughbore 18.

[0027] Although only a few exemplary embodiments of this invention have been described in detail above, those skilled in the art will readily appreciate that many other modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the following claims.